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ROAD LOG TO THE GEOLOGY OF THE ABINGDON AND SHADY VALLEY QUADRANGLES

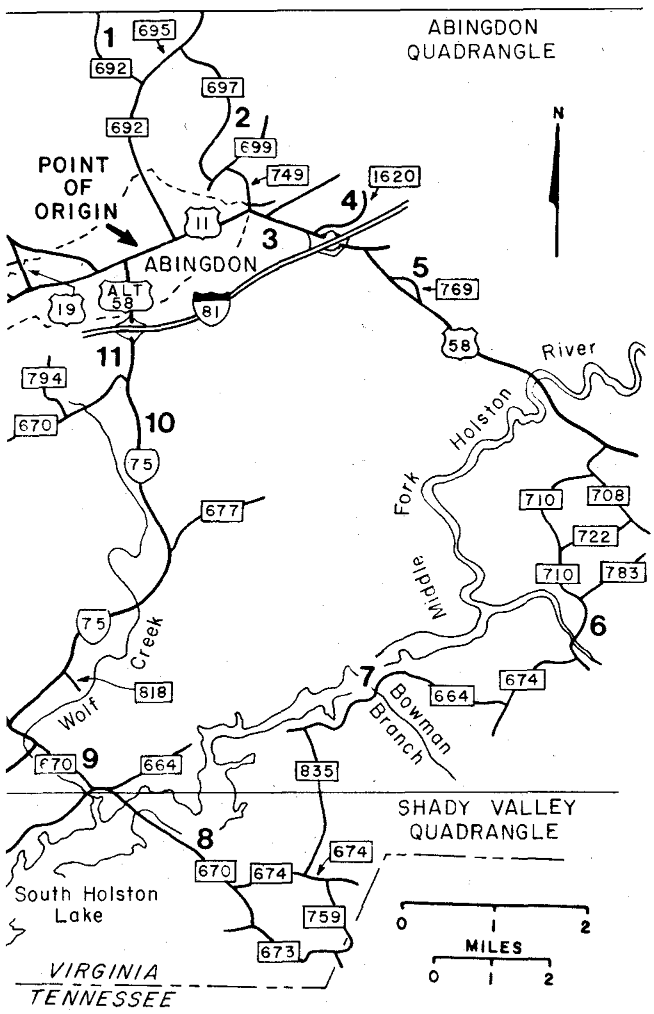
Charles Bartlett and Thomas Biggs

This road log is a guide to some of the significant geologic features in the Abingdon and Shady Valley quadrangles. The lower Paleozoic rocks in this area are mainly carbonates and shales. At places fossil gastropods are in the carbonates and there are graptolites in the Athens shales. The strata lie in a sequence of major folds, both open and overturned, characteristic of the Ridge and Valley province. The route crosses these structures and also the Pulaski, Spurgeon and Alvarado thrust faults and the Dry Run cross fault. Cataclastic rocks are associated with the faults. Karst topography is well developed in the Holston River Valley.

A generalized map of the area showing the 41-mile route of the road log is shown. Topographic maps of the Abingdon and Shady Valley quadrangles may be obtained from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, Virginia 22903. A county road map of Washington County is available from the Information Office, Virginia Department of Highways, 1221 East Broad Street, Richmond, Virginia 23219 or the Residency Shop in Ablingdon.

Permission should always be obtained before entering private property.

CUMULATIVE DISTANCE MILES Km	*DISTANCE* MILES Km	*EXPLANATION*
0.0 0.0	0.0 0.0	Begin in Abingdon at the fire hydrant on Main Street (U. S. Highway 11) in front of the Martha Washington Inn. Head east.
0.4 0.64	0.4 0.64	Washington County Courthouse on left.
0.5 0.80	**0.1** 0.16	**House on left. Behind house is "Wolf Cave" formed in Chepultepec limestone.** It is said that wolves from this cave attacked a party led by Daniel Boone, hence an early name for Abingdon was Wolf Hills.



Index map for road log.

CUMULATIVE DISTANCE **MILES** Km	*DISTANCE* **MILES** Km	*EXPLANATION*
0.6 0.97	**0.1** 0.16	Turn left onto Tanner Street.
0.7 1.13	**0.1** 0.16	Turn right onto Valley Street.
0.8 1.29	**0.1** 0.16	Turn left onto State Road 692 (White Mill Road).
2.0 3.22	**1.2** 1.93	Sandstone from the Conococheague Formation in the right roadbank.
2.1 3.38	**0.1** 0.16	Shale chips weathered from the Nolichucky in the right roadbank.
2.4 3.86	**0.3** 0.48	Conococheague and Nolichucky beds are overridden by the Honaker dolomite along small thrust fault.
2.6 4.19	**0.2** 0.32	Road junction with State Road 695, bear left and continue on State Road 692.
2.9 4.67	**0.3** 0.48	In left roadcut is Honaker dolomite which has south dip.
3.3 5.30	**0.4** 0.64	In right roadbank is fractured Honaker dolomite.
3.5 5.62	**0.2** 0.32	**STOP 1.** Honaker dolomite with abundant fractures and calcite veins on right in roadcut. Zone is near the base of a secondary thrust sheet associated with the Pulaski fault. Continue north.
3.9 6.28	**0.4** 0.64	The small valley on the right lies on the trace of the main Pulaski thrust fault along which the Honaker Formation is in contact with the Knox Group, upper part.
4.0 6.44	**0.1** 0.16	Outcrops in right road bank are dolomite with white chert of the Knox Group, upper part.
4.3 6.92	**0.3** 0.48	Return south to State Road 695.
6.0 9.66	**1.7** 2.74	Turn left onto State Road 695.
6.5 10.46	**0.5** 0.80	Some deep sinkholes on the left in a limestone and dolomite unit in the middle portion of the Honaker Formation.
6.7 9.79	**0.2** 0.32	Turn right onto State Route 697.
6.9 11.11	**0.2** 0.32	Outcrops on left: dolomite in upper part of Honaker Formation.
7.2 11.59	**0.3** 0.48	Weathered Nolichucky shale in left roadbank.
7.3 11.75	**0.1** 0.16	Sandstone layers near base of Conococheague Formation in left roadbank.
7.5 12.07	**0.2** 0.32	On left limestone and dolomite of Conococheague Formation. Note springs near the creek.
8.1 13.04	**0.6** 0.97	**STOP 2.** Conococheague Formation outcrops are on left of road. Rocks of this unit include light-gray dolomite, laminated bluish-gray limestone and a layer of limestone-pebble conglomerate.
8.6 13.84	**0.5** 0.80	Abandoned quarry on left at curve is in Conococheague Formation dolomite and limestone.
8.8 14.16	**0.2** 0.32	Turn left onto State Road 699.
9.0 14.48	**0.2** 0.32	Turn right onto road to E. B. Stanley Elementary School.
9.2 14.80	**0.2** 0.32	Outcrops of Conococheague sandstone and limestone on right in front of school.
9.5 15.28	**0.3** 0.48	On right behind the William Neff Technical School (circular building) is thick-bedded Chepultepec limestone.
9.7 15.62	**0.2** 0.32	Turn left onto State Road 749 at County school office building.
9.9 15.94	**0.2** 0.32	Stop sign. Turn left on U. S. Highway 11.
10.0 16.10	**0.1** 0.16	Cross Norfolk and Western Railway overpass.
10.4 16.74	**0.4** 0.64	**STOP 3.** Spurgeon fault trace with bouldery breccia exposed on both sides of the highway. Breccia is in near vertical beds of the Honaker Formation which was thrust upon the Knox Group, upper part. The fault overlies a portion of the axial trace of the Abingdon syncline. Continue to southeast on U. S. Highway 11.
10.8 17.38	**0.4** 0.64	Turn left at Texaco station onto service road on north side of Interstate Highway 81.
11.4 18.34	**0.6** 0.97	Turn left onto State Road 1620.
11.45 18.43	**0.05** 0.08	**STOP 4.** Walk 50 yards west to small waterfalls in Fifteenmile Creek; waterfalls are formed in Nolichucky limestone beds. Beds here are representative of this unit in areas south of the Spurgeon fault. The reddish-brown, wavy, silty, raised laminae in the bluish-gray micrite is distinctive. Note also thin lenses of oolitic, fossiliferous limestone-pebble conglomerate. The site of an ancient Indian campground was partially excavated here in 1972. A charcoal sample from the site dated 585 A.D. Continue north into a housing development.
11.7 18.84	**0.25** 0.40	Turn around. The Spurgeon fault may be traced on the hill to the west (across the creek). Nearly vertical beds of Honaker Formation and more gently inclined beds of Chepultepec limestone are north of the fault. The strike of the Honaker beds is almost perpendicular to that of the Chepultepec. Return to U. S. Highway 11.
12.6 20.29	**0.9** 1.45	Stop sign. Turn left onto U. S. Highway 11.
12.7 20.45	**0.1** 0.16	Pass under Interstate Highway 81.
13.1 21.09	**0.4** 0.64	Turn right onto U. S. Highway 58 (J. E. B. Stuart Highway).
13.4 21.57	**0.3** 0.48	Overturned and cleaved, graptolite-bearing Athens shales in right roadcut.
13.7 22.06	**0.3** 0.48	Turn left onto State Road 769, a gravel road.

CUMULATIVE DISTANCE MILES Km	*DISTANCE* MILES Km	*EXPLANATION*
14.0 22.54	**0.3** 0.48	**STOP 5.** Large borrow pit in Athens Formation shale which contains beds with thin siltstone partings and axial plane cleavage. Dip is about 35 degrees to the northwest into the Great Knobs syncline. Continue south.
14.1 22.70	**0.1** 0.16	Quarry on left in limestones of Lenoir-Mosheim and dolomite of Knox Group, upper part. Stop sign; turn left onto U. S. Highway 58.
14.6 23.50	**0.5** 0.80	Road is at angle of dip slope of Conococheague beds.
14.9 23.98	**0.3** 0.48	Crest of hill is at axis of Watauga anticline.
15.4 24.78	**0.5** 0.80	Roadbank exposures of south dipping dolomite in Knox Group, upper part.
15.7 25.26	**0.3** 0.48	Hillside cuts in Athens Formation.
15.8 25.58	**0.1** 0.16	Bridge over Middle Fork Holston River.
15.9 25.53	**0.1** 0.16	Rapids on right in river formed by resistive sandstone and siltstone layers in Athens Formation near axis of River Knobs syncline.
16.3 26.24	**0.4** 0.64	Road cut through dark-gray, fissle shale of Athens Formation with thin layers of sooty-gray bentonite (?) and with pyrite and tiny gypsum crystals.
16.7 26.88	**0.4** 0.64	Roadway on dip slope of dolomite in Knox Group, upper part, on north flank of Parks Mill anticline.
17.0 27.36	**0.3** 0.48	Crossing axial trace of Park Mill anticline.
17.1 27.52	**0.1** 0.16	Turn right onto State Road 708.
17.4 28.00	**0.3** 0.48	Sharp left curve.
17.5 28.16	**0.1** 0.16	Road junction at right with State Road 710, continue on 708.
17.7 28.48	**0.2** 0.32	Bethel Elementary School on left.
18.0 29.96	**0.3** 0.48	Outcrops in fields of Lenoir-Mosheim limestone with some conglomerate at the base of the unit (Middle Ordovician unconformity). To left, on hillslope, is exposure of shale in the Athens Formation which is in a syncline.
18.1 29.12	**0.1** 0.16	Crossing axial trace of same syncline. Holston Mountain is on horizon ahead.
18.2 29.30	**0.1** 0.16	Turn right onto State Road 722.
18.7 30.10	**0.5** 0.80	Karst topography on left in Chepultepec limestone; solution weathering is enhanced by fractures along a thrust fault. Note the disappearing stream in pig pen.
19.1 30.74	**0.4** 0.64	To the right along creek are outcrops of Chepultepec limestone.
19.2 30.90	**0.1** 0.16	Junction on right with State Road 710; continue ahead on State Road 710.
19.3 31.06	**0.1** 0.16	Trace of an unnamed thrust fault intersects road.
19.5 31.38	**0.2** 0.32	Outcrops in left roadbank of limestone in Conococheague Formation.
19.8 31.86	**0.3** 0.48	Roadcut on left in Conococheague limestone with two prominent sandstone beds. Just beyond is junction with State Road 783; turn right and continue on State Road 710.
20.3 32.66	**0.5** 0.80	**STOP 6.** Roadcut in limestone and dolomite assigned to the Chepultepec and Knox Group, upper part. Note terrace gravels high on outcrop at left. Walk ahead 50 yards to bridge on South Fork Holston River. Upstream are rapids of resistive Lenoir-Mosheim limestone. The trace of the Alvarado cross fault is beneath the west end of the bridge.
20.35 32.76	**0.05** 0.08	Cross bridge. Hill on right ahead is of Athens Formation.
20.5 33.00	**0.15** 0.24	Alvarado community.
20.55 33.08	**0.05** 0.08	Cross Norfolk and Western Railway tracks.
20.7 33.32	**0.15** 0.24	Turn right onto State Road 674.
20.8 33.48	**0.1** 0.16	Outcrops near road are Knox Group, upper part.
21.2 34.12	**0.4** 0.64	About 100 feet at right, Lenoir-Mosheim limestones terminate against Athens shale at a normal fault. Beyond, about 150 yards north of the road, is an exposure of southward dipping, Middle Ordovician rocks in a fault-bounded, graben-like structure.
21.55 34.68	**0.35** 0.56	Base of Athens Formation.
22.0 35.40	**0.45** 0.72	Turn right onto gravel road, State Road 664, to South Holston Lake.
22.05 35.48	**0.05** 0.08	On left are overturned beds of Lenoir-Mosheim limestones.
22.1 35.58	**0.05** 0.08	Roadcut on left in overturned Athens shale.
22.35 35.98	**0.25** 0.40	Outcrops on both sides of road are in Knox Group, upper part dolomite and Lenoir-Mosheim limestone. The dip is south.
22.4 36.06	**0.05** 0.08	Right roadcut has vertical beds of Athens shale.
22.45 36.14	**0.05** 0.08	Thick-bedded conglomeratic sandstones on right have steep dip to the northwest.
22.6 36.38	**0.15** 0.24	The same conglomeratic sandstone unit has dip to southeast. The principal axis of the South Holston syncline lies between these two exposures.
23.3 37.51	**0.7** 1.13	Lenoir-Mosheim limestone on left roadbank and on hillslope to right across Bumgardner Branch.
23.9 38.47	**0.6** 0.96	**STOP 7.** From top of hill walk 50 yards to right (west) toward Bowman Branch. Trench in hemlock grove is an old iron prospect pit in cherty dolomite of the Knox Group, upper part. These trenches, which are both sides of Bowman Branch, represent the Riverside, or Holston,

CUMULATIVE DISTANCE **MILES** Km	*DISTANCE* **MILES** Km	*EXPLANATION*
		mine.
24.0 38.64	**0.1** 0.16	Outcrops here and for the next 3.5 miles (5.6 km) are primarily in Athens Formation shales and sandstones which are steeply inclined southward and are partly overturned.
24.2 38.96	**0.2** 0.32	Iron prospect pits in woods on right.
24.7 39.76	**0.5** 0.80	Outcrop of Lenoir-Mosheim limestone in Mays Branch.
25.6 41.21	**0.9** 1.45	Road junction, turn left onto State Road 835.
26.3 42.34	**0.7** 1.13	On left are some ledges of conglomeratic sandstone in the Athens.
26.4 42.50	**0.1** 0.16	Additional ledges of conglomeratic sandstone.
26.8 43.14	**0.4** 0.64	Cross Lick Branch. Just across creek is folded and contorted Athens shale and siltstone.
27.0 43.46	**0.2** 0.32	Additional folded Athens beds on right bank.
27.5 44.28	**0.5** 0.80	Road junction, turn left onto State Road 674. In flat field just ahead is approximate trace of Dry Branch cross fault; hill is underlain by Chepultepec limestone which is mostly overturned; dip is to the southeast.
27.85 44.84	**0.35** 0.56	Turn right onto State Road 759.
27.9 44.92	**0.05** 0.08	On left bank are sandstone gravels of a former steam channel in Athens shale. Ahead is Holston Mountain.
27.95 45.00	**0.05** 0.08	Cross trace of Dry Creek fault.
28.0 45.08	**0.05** 0.08	On right hillslope are Conococheague Formation outcrops; dip is about 64 degrees northwest.
28.6 46.05	**0.6** 0.97	Enter Sullivan County, Tennessee.
28.9 46.53	**0.3** 0.48	Re-enter Washington County, Virginia Ditches on both sides contain weathered maroon shales of the Rome Formation.
29.1 46.85	**0.2** 0.32	Road junction, turn right onto State Road 673. Hillslope on right are of highly contorted dolomite of Honaker Formation.
29.7 47.82	**0.6** 0.97	Sandstone and quartzite colluvial gravels on left bank.
29.9 48.14	**0.2** 0.32	Good exposure in field to right of overturned Honaker dolomite and limestone.
30.1 48.46	**0.2** 0.32	On left in curve of road just northwest of a driveway is laminated limestone of the Nolichucky Formation. The lithology is nearly identical to that near Abingdon (see Stop 4).
30.2 48.62	**0.1** 0.16	On clear days Clinch Mountain can be seen in the distance straight ahead.
30.45 49.02	**0.25** 0.40	Turn right onto State Road 670.
30.5 49.10	**0.05** 0.08	Outcrops on right in overturned Conococheague limestone, dolomite and sandstone.
30.7 49.42	**0.2** 0.32	Overturned beds of Chepultepec limestone on right.

CUMULATIVE DISTANCE **MILES** Km	*DISTANCE* **MILES** Km	*EXPLANATION*
30.9 49.74	**0.2** 0.32	At barn on left is dolomite of the Knox Group, upper part, and limestone of Lenoir-Mosheim, which contains some dolomite-pebble conglomerate at its base. The beds are overturned; dip is southeast.
30.95 49.82	**0.05** 0.08	Graptolite-bearing shales near base of Athens Formation in left roadcut.
31.05 49.96	**0.1** 0.16	Road junction with State Road 674. At stop sign turn left onto 670.
31.5 50.72	**0.45** 0.72	Bedding plane surface of Athens exposed on right has mudcracks.
31.7 51.04	**0.2** 0.32	**STOP 8.** Trace of Dry Run cross fault is along lake. Across road is a spectacular example of polymictic conglomerate of the Athens Formation. Pebbles of limestone, dolomite, chert, jasper, and quartzite are in several layers. Continue north.
31.9 51.36	**0.2** 0.32	South Holston Lake to right.
32.6 52.49	**0.7** 1.13	Avens Bridge over South Holston Lake. Athens Formation shales and siltstones are to the left and Knox Group, upper part and Lenoir-Mosheim beds are to the right. Good exposures of Middle Ordovician unconformity and associated erosional conglomerates are on north shore to right.
33.0 53.13	**0.4** 0.64	Road junction with State Road 664; continue ahead on State Road 670.
33.2 53.45	**0.2** 0.32	**STOP 9.** Park on left of road. To right, roadcut is in Conococheague Formation; rocks include cross-bedded and ripple-marked sandstone, thin laminated dolomite, limestone with algal-mound structures, ribbon-banded limestone and some chert nodules. Continue north.
33.5 53.94	**0.3** 0.48	Cross axis of Parks Mill anticline. Fold axis is in Conococheague beds on the hillslope on the left across Wolf Creek.
33.9 54.58	**0.4** 0.64	Stop sign. Junction with State Highway 75. Continue ahead to northwest on State Highway 75. Outcrops on left are Chepultepec limestone.
34.15 54.98	**0.25** 0.40	Bridge over Wolf Creek. Outcrops on left ahead are Lenoir-Mosheim limestones; dip is northwest.
34.3 55.22	**0.15** 0.24	On right bank of creek graptolite-bearing, fissile Athens shale lies near axis of River Knobs syncline.
34.45 55.48	**0.15** 0.24	Sharp right turn on State Highway 75 at junction with State Road 665. Continue on State Road 75.
35.0 56.35	**0.55** 0.88	Sinkholes and karst topography on left in Chepultepec limestone along axis of Watauga anticline. Gastropod-rich limestone beds of the Knox Group, upper part, and Lenoir-Mosheim are on the lower slopes of hill on right.
35.8 57.63	**0.8** 1.28	Rock walls of house on left are of chert weathered from the Knox Group, upper part.
36.7	**0.9**	Bridge across Wolf Creek. Outcrops in

CUMULATIVE DISTANCE MILES Km	*DISTANCE* MILES Km	*EXPLANATION*
59.08	1.45	creek of Knox Group, upper part dolomite at the axis of the Watauga anticline.
37.5 60.37	0.8 1.29	Road junction on right with State Road 677, turn left and continue north on State Highway 75.
37.9 61.02	0.4 0.64	Dip of Athens shale in quarry on right is 43 degrees northwest into the Great Knobs syncline.
38.1 61.34	0.2 0.32	Conglomeratic arkosic sandstones of the Athens Formation exposed in right roadcut.
38.4 61.82	0.3 0.48	Small synclinal fold in Athens sandstones on right.
38.5 61.98	0.1 0.16	STOP 10. Fault in Athens Formation sandstone and shale in roadcut on right at a curve in the road.
38.85 62.54	0.35 0.56	Beds of Athens Formation in roadcut on left are folded and fractured. Formation is prone to rapid mass wasting on steep slope such as in cut.
39.4 63.42	0.55 0.88	On the right are nearly vertical beds of Athens Formation on the north side of Great Knobs syncline.
39.6 63.74	0.2 0.32	Road construction in 1972 sliced through an ancient, pallisaded Indian village which dates at 1425 A.D.
39.9 64.22	0.3 0.48	STOP 11. Alvarado fault zone is exposed in roadcut and in a small pit on left side of road. Beds of limestone and dolomite in the Conococheague are highly contorted where the trend of the fault changes from northwest to east - southeast.
40.3 64.88	0.4 0.64	Interstate Highway 81 underpass. Axis of Stone Mill anticline.
40.85 65.76	0.55 0.88	Crossing axial trace of Abingdon syncline.
40.95 65.92	0.1 0.16	Crossing trace of Spurgeon thrust fault.
41.0 66.00	0.05 0.08	Norfolk and Western Railway overpass. To left along railroad are outcrops of the Knox Group, upper part dolomite which is in fault contact with Conococheague rocks.

END OF ROAD LOG

STAFF NOTES

Effective Dec. 1, 1979 Dr. Mervin J. Bartholomew, a native of Pennsylvania, joined the permanent staff of the Division of Mineral Resources where he had worked as a nonpermanent employee for the previous 2½ years in the western mapping section. Jerry received his B.S. in geological sciences from The Pennsylvania State University in 1964. This was followed by a year of graduate work at the University of Georgia before moving to California in 1965. There he accepted a job with Standard Oil Company of California (Chevron) for whom he worked until 1968. During the 3 years he worked at their Inglewood district office he attended night school at the University of Southern California where he received his M.S. in geology in 1969. During these years he also gained additional field experience with Tennessee Copper Company and the Central Savannah River Area Project in Alabama and Georgia, respectively, as well as with the Atlantic-Richfield Oil Company and the Los Angeles County Museum in California.

In 1971 Jerry received his Ph.D. in geological sciences from the Virginia Polytechnic Institute & State University and subsequently taught there as well as at North Carolina State University and Longwood College until 1975. Since 1975 he has done geologic mapping for both the Virginia Division of Mineral Resources and the North Carolina Division of Land Resources. In addition to publications prepared for both states, Jerry has also published articles on: the San Jacinto fault in California; late Quaternary faulting in The Olympic Peninsula in Washington; ptygmatic features; and the middle Ordovician Trilobite, **Microparia.**

Jerry currently works at the Department of Geological Sciences, Virginia Polytechnic Institute & State University where he serves on thesis committees of students whose research is funded by the Division. His current assignments include 7½-minute quadrangle mapping in the Roanoke-Pulaski-Pearisburg region as well as an examination of Mississippian coals in the same area.

WHAT'S IN A NAME?

Did you know that the mineral name amethyst was derived from the Greek words meaning "not" and "drunk" because the mineral was supposed to have the power to remedy drunkenness? "Garnet" came from the Latin word for pomegranate, whose seeds were thought to resemble the mineral.

The derivations of mineral names are diverse. Most are taken from personal names but many are based on mineral characteristics, geographical names, objects the mineral resembles and sometimes, on physical concepts.

In "Mineral Names: What Do They Mean?" published in 1979, Richard Scott Mitchell of the University of Virginia discusses various ways minerals have been named in the past and presents guidelines for naming newly discovered minerals. He also lists in alphabetical order 2600 mineral names and their origins. The book is available for $13.95 from Van Nostrand Reinhold Company, 7625 Empire Drive, Florence, Kentucky 41042.

Purchase Instructions

GQ, I, P*, RI* and VB*

Order by letter and number designation from the following address. Most of these maps have accompanying explanatory reports. A List of Publications is available upon request.

Virginia Division of Mineral Resources
P. O. Box 3667
Charlottesville, Virginia 22903

B, GQ, I, MF, and WSP

Order by letter and number designation from:

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OF

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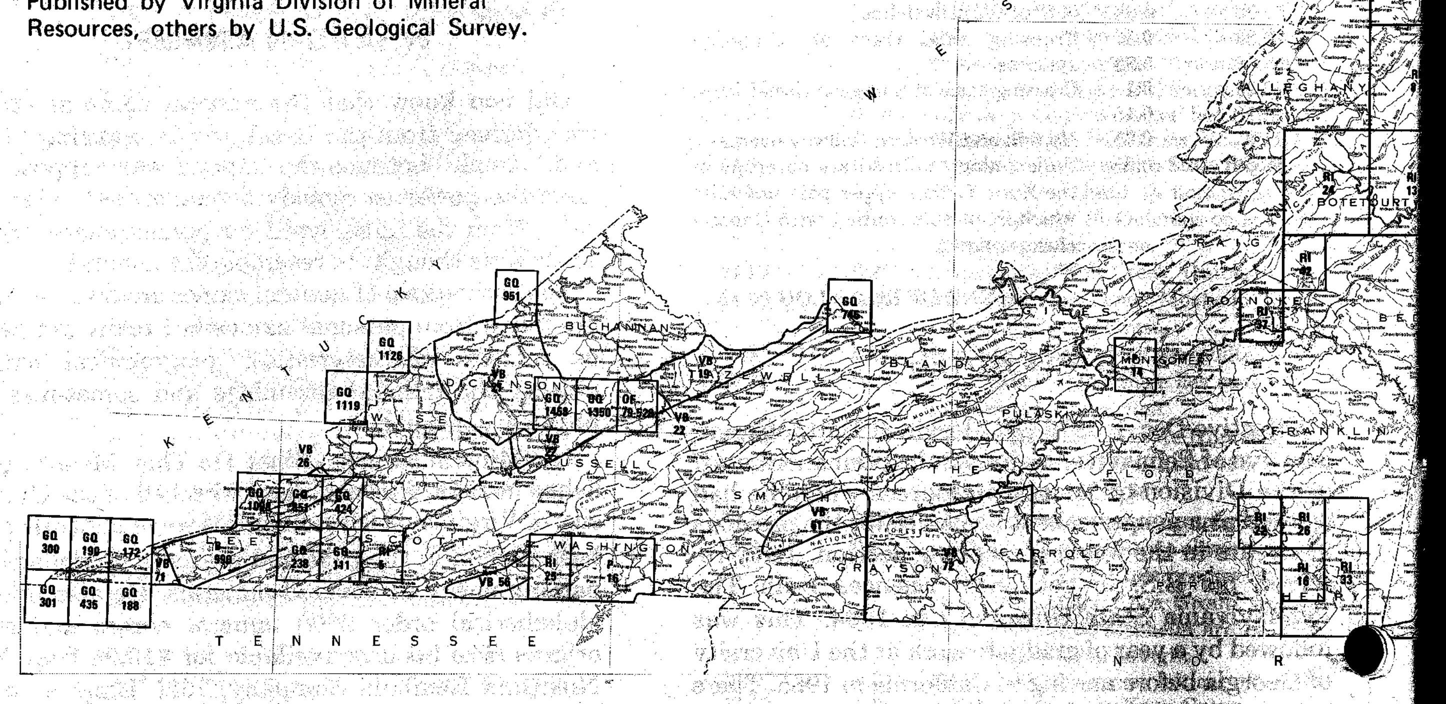
Denver, Colorado 80225

B — Bulletins, GQ — Geologic Quadrangles, I — Miscellaneous Investigations Series, MF — Miscellaneous Field Studies, OF — Open File Reports, P — Publications, RI — Reports of Investigation, VB — Bulletins, WSP — Water Supply Papers

A listing of available, geologic publications by the Division on Virginia can be obtained from the above Charlottesville address.

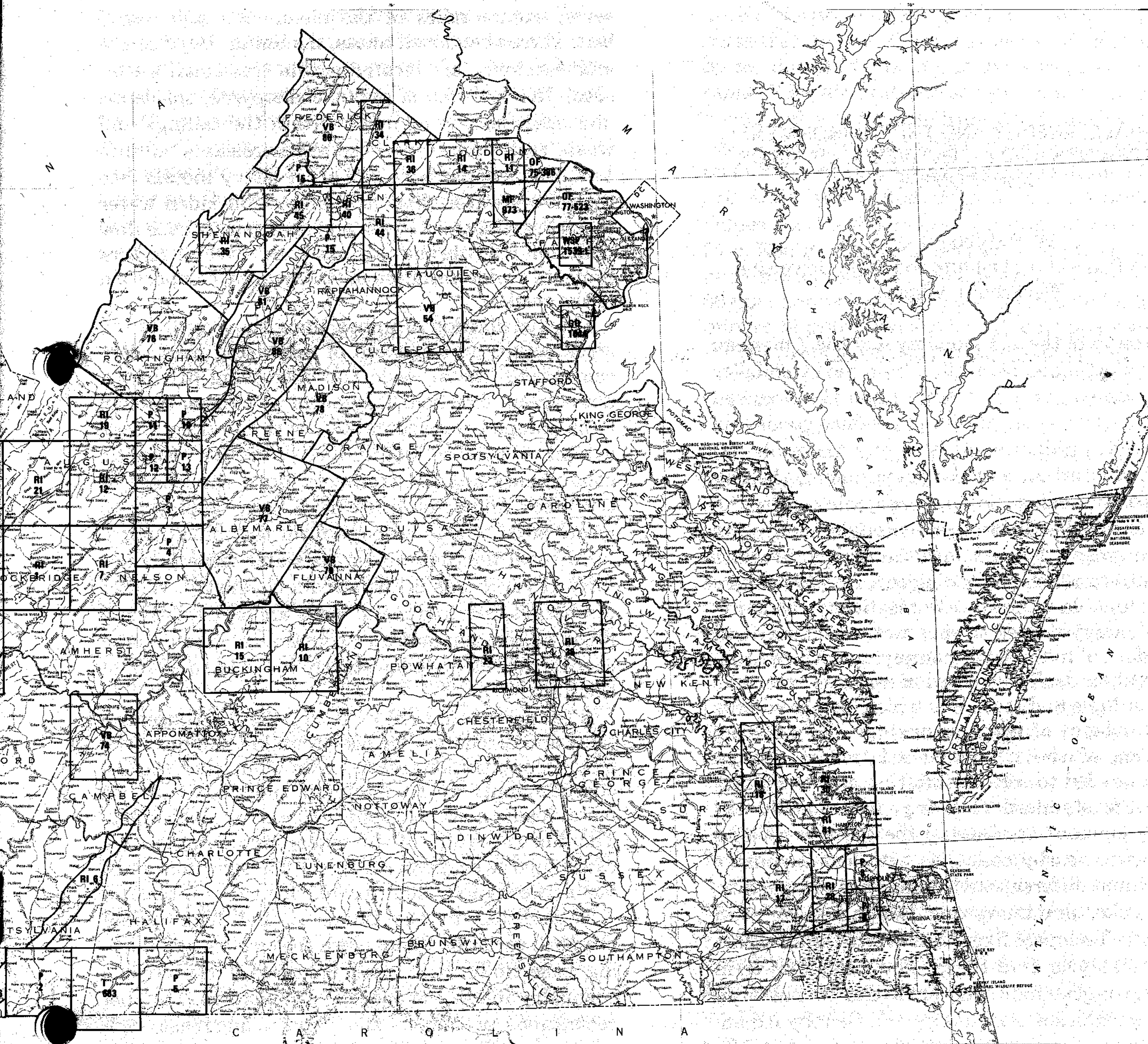
* Published by Virginia Division of Mineral Resources, others by U.S. Geological Survey.



INDEX TO AVAILABLE GEOLOGIC MAPPING OF VIRGINIA

Scales 1:24,000 to 1:62,500

Mapped areas are outlined and labeled for reference in purchasing. Where several maps depict the same area only the more detailed map is shown.



AIME ABSTRACTS

The following are abstracts or portions of abstracts from papers which were presented at the November, 1979 meeting, of the Virginia Section of the American Institute of Mining Engineers held in Charlottesville. The theme of the meeting was "Mining and the Environment in Virginia". For more information on upcoming AIME meeings contact Richard S. Good or Robert C. Milici, Division of Mineral Resources, Box 3667, Charlottesville, Virginia 22903.

MATERIALS, ENERGY AND THE ENVIRONMENT: CONSTRAINTS AND INCENTIVES — CRISIS OR COMPROMISE

W. R. Hibbard, Jr.
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

The growth of the US economy and the American standard of living have resulted from the availability of material and energy resources and the financial and manufacturing capability to produce goods and services. The production of fuels and materials requires the disturbance of the environment, thereby leading to political, social and economic conflict relative to the trade-offs between materials, energy and the environment. Present laws involve constraints and incentives which are leading to a situation where the US is unable to produce domestically the materials and energy needed to sustain the economy and the standard of living while complying with environmental standards. This situation requires extensive imports of fuels and materials which lead to serious negative balance of fiscal payments. The resulting devaluation of the US dollar relative to foreign currency has led to serious inflation and escalating costs of the standard of living. Additionally US mining companies are leaving the US and seeking operations in nearby countries with less expensive resources and different environmental laws particularly oil, coke, aluminum, zinc, lead, alloys for steel and copper. Technical fixes to alleviate the situation require 10-12 year lead times. Thus, the near term forecasts suggest improved environment but very expensive materials and energy and thereby expensive goods and services with shortages unavoidable.

THE ACID MINE DRAINAGE OF CONTRARY CREEK: FACTORS CAUSING VARIATIONS IN STREAM WATER CHEMISTRY

Thomas V. Dagenhart, Jr.
Department of Environmental Sciences
University of Virginia
Charlottesville, Virginia

Contrary Creek in Louisa County, Virginia drains seven square miles of the piedmont's gold-pyrite belt. Three abandoned mines, the Sulfur, Boyd Smith and Arminius, are located within this small watershed. The oxidation of pyrite, chalcopyrite, sphalerite, and other sulfide minerals within the tailings and waste rock dumps of these mines releases sulfuric acid, iron, copper, zinc and other heavy metals into the groundwater. This acid and metal laden water seeps into Contrary Creek and maintains a base flow pollution load throughout the year. Several factors promote a wide variation in the chemical composition of the creek.

The distribution of mines along the length of the creek results in a pattern of increasing metal concentrations, metal loads and decreasing pH in the downstream direction. Tributaries which flow through mine dumps before confluence with Contrary Creek exhibit a similar longitudinal variation. Specific conductance and pH transects along the length of the creek and tributaries have been employed to locate sites of acid seepage from the mine dumps.

Seasonal fluctuations in the water table produce cyclical variations in the stream chemistry. Winter discharges, pH, and metal loads are high relative to those of the summer and conversely winter metal concentrations are consistently lower than those of the summer.

A ten percent diurnal variation of metal concentrations and discharge has been found in summer. The metal concentrations reach a maximum when the discharge and pH reach a minimum and vice versa. The metal loads, however, appear to remain unchanged. The diurnal nature of this phenomenon suggests a cause such as evaporation and/or transpiration which has a twenty-four hour periodicity to its intensity.

In addition to the temporal and longitudinal chemical variation found when the creek is approaching base flow, very rapid changes of the creek's chemistry follow the onset of a rainstorm. The concentrations of copper, zinc, iron, manganese, cadmium, and other metals increase very sharply during

the first few hours of rising discharge. Simultaneously metal loads rapidly increase and pH drops. The swift chemical response indicates that surface run-off transports the metals into the stream rather than water which has infiltrated and leached the tailings piles. Soluble efflorescent sulfate minerals such as melanterite, rozenite, ferricopiapite, halotrichite and chalcanthite are abundant during dry weather especially at the Sulfur Mine and they are inferred to be a major metal source for the surface runoff. Many other sulfates have been identified in lesser amounts i.e. alunogen, magnesiocopiapite, aluminocopiapite, pickeringite, gypsum, ferrohexahydrite, siderotil, szomolnokite, jarosite, rhomboclase, fibroferrite, coquimbite, paracoquimbite, antlerite, brochantite, linarite, anglesite, serpierite, gunningite, and epsomite. After the sulface efflorescences and crusts are flushed away, the unpolluted runoff from the upper watershed arrives. This relatively fresh water produces a net dilution of the creek.

GEOCHEMISTRY OF DUMPS AND DRAINAGE AT GOSSAN LEAD MINE, GALAX, VIRGINIA

Richard S. Good
Virginia Division of Mineral Resources

From 1789 to 1976 massive to near-massive lenses of sulfides have been mined for iron, copper, and iron sulfide for the manufacture of sulfuric acid. About 90% of the ore is pyrrhotite with the remainder largely sphalerite, chalcopyrite, and scattered galena. The sulfide lenses are conformable to the enclosing metasedimentary mica schist and gneiss of the Precambrian Ashe (Lynchburg) Formation and occur in a NE-trending zone 17 miles long. The deposits are considered to be synsedimentary pyrite, related to volcanigenic processes, later metamorphosed to pyrrhotite. Minor metavolcanic rocks occur within the ore zone.

The leveled top of the dumps consists of unsorted schist fragments and fines mixed with goethite and poorly soluble sulfates like jarosite. This surface was limed to counteract a pH of 2.5-3.1 and seeded with grass and pine. Drainage underneath the dumps, continues, however, because of the presence of a former stream bed, now completely covered. Soluble heavy metal sulfates continue to drain from the raw east tailing slopes into the mine run (Red Branch) which empties into Chestnut Creek about one half mile to the east. Sulfates identified on the eastern tailing slopes include: coquimbite, rozenite, copiapite, pickeringite, melanterite, ferrohexahydrite, szomolnikite, and chalcanthite. These more soluble sulfates are subject to metal flushing during heavy storms, then build up in dry periods. Iron hydroxide is precipitated in Red Branch by oxidation of ferrous sulfate to ferric sulfate and hydrolysis during dry periods. Iron flocculent ("yellow boy") is largely removed during heavy storms scouring. Simple, physical mass-transport of dump derived sediment is shown by an almost identical iron average ($x = 13.8\%$ Fe, range 7-20) for 17 dump samples and 5 stream sediments (-80 + 230 mesh) from Red Branch with 14.8 - 16.4% Fe. Chestnut Creek near-bank stream sediment 200 feet below Red Branch contained 2.1% Fe and 2.9% above Red Branch, normal background values for the Piedmont. Dilution of other metals from Red Branch sediment were: Cu from 850 to 44 ppm downstream (8 ppm upstream); Zn from 450 to 80 ppm downstream (41 ppm upstream); Pb from 260 ppm to 17 ppm downstream (19 ppm upstream).

Red Branch water contains 5,000 ppm Fe and ranges in pH from 2.8 to 3.5 at entrance to Chestnut Creek, with up to 43 ppm Zn, 73 ppm Mn, 2.4 ppm Cu, 0.37 ppm Pb. Red Branch drainage except during storms, is minor and rapidly diluted. High heavy metals and low pH are sharply confined to a 5 foot wide strip out of a total width of 65 feet in Chestnut Creek. The acid bank strip 300 feet downstream had increased to a pH of 6.4 compared to 6.8-7.0 outside strip; Fe, 13 ppm, 1 ppm or less outside; Zn 0.18 ppm, 0.02 ppm outside; Cu, 0.02 ppm. n.d., 0.02 outside; Mn, 1.1 ppm compared to n.d. to 0.13 ppm outside strip. Pb n.d. in plume or stream.

Further drainage from underground workings was formerly provided by a half mile conduit, Ingram Tunnel, which drained north into Chestnut Creek from the 350 foot mine level, until it was sealed with concrete in 1977. Chestnut Creek directly below Ingram T. showed minimal discharge, probably from metal-saturated soil and waste, not from the tunnel. Water values at bank were 3.5 ppm Fe compared to 2.4 to 2.6 up, down, and cross stream and pH 5.6 at bank with 6.4 up, down, and cross stream. Allied Chemical Company is currently considering an additional proposal for reclamation by impoundment of Red Branch headwaters and recirculation by pumping them back to the open pit, eventually filling the now-sealed underground mine.

RECLAMATION OF STEEPLY SLOPING TERRAIN IN COALFIELDS

H. G. Goodell
Department of Environmental Sciences
University of Virginia

The federal Surface Mining Control and Reclamation Act of 1977 (PL 95-87) attempts to minimize the adverse social, economic and environmental effects of mining operations. The legislation acknowledges that, because of the wide diversity of climatological, ecological and geological conditions in areas subject to mining, the primary responsibility for "developing, authorizing, issuing and enforcing regulations for surface mining and reclamation operations subject to this Act should rest with the states (Sec. 101f)." Among the environmental protection and performance standards (Sec. 515) provided by the legislation is the backfilling with spoil so as to completely cover the mine high wall, thus returning the site to the original contour. However, variances to the reclamation guidelines are allowed if these alternatives offer equal or improved environmental, hydrologic, ecologic and/or land use conditions. The Virginia Coal Surface Mining Control and Reclamation Act of 1979 (45.1-226) accepts the federal reclamation standards while providing for their regulation and administration by the Commonwealth.

In southwestern Virginia the steep, geomorphologically mature valleys are underlain by predominantly flat-lying Pennsylvanian strata which consist of shales, coal and thick bedded competent subgraywacke sandstones. These sandstones comprise the high walls of the open-cut mines where the coal is taken from a series of benches or terraces working back from the crop and following the contour along the slope. The benches are sloped back to the high wall. Mining ratios are usually no less than 10:1 which generally results in high walls of 40 to 60 ft., although high walls of up to 150 ft. occur. Prior mining practices allowed spoil to be placed over the edge of the bench followed by hydroseeding of the entire mine workings. The coal, shale and sandstones are usually low in sulfur and offer no geochemical impediment to a normal ecological floral succession even on the spoil slopes. The grassy benches provide a maximum of ecological habitat diversity as well as choice locations for public works, agriculture (including tree farming and grazing), and recreation. The sandstone high walls are visually attractive and offer new scenic alternatives in otherwise steep hilly terrain covered with mixed conifers and hardwoods. Hydrologically the unforested benches do contribute to the "flashiness" of flooding, particularly in the first order streams.

In contrast, the return-to-contour high wall fills of the new federal legislation offer maximum exposure of disturbed earth at slopes near the angle of repose to sheet wash erosion, circular slope failures, and slumping. Effective stabilization of these slopes will be prohibitively expensive. However, even if stabilized the hydrologic characteristics of the recontoured fills are even worse than those of the benches and should promote even more intense flash flooding.

Virginia's Surface Mining Control and Reclamation Act should be revised so as to offer maximum flexibility in mining and reclamation while at the same time providing environmental safe guards. The mine and reclamation plan submitted as a part of the permitting process should be judged by a panel of ecological, geological, hydrological, and land-use experts as to its soundness and feasibility given all of the physical and biological constraints of the mine site. Minimization of surface exposure and adequate drainage of mine tailings is desirable, particularly if these constitute an environmental hazard. Mine cuts on steep slopes are not categorically bad if the high walls are stable and if the benches and slopes are hydroseeded and reforested.

USE OF MYCORRHIZAE ON PINE SEEDLINGS IN COAL FIELD RECLAMATION

J. D. Artman - Pathologist
Virginia Division of Forestry

Mycorrhizal organisms are beneficial fungi that infect plant roots and yet enter into a symbiotic relationship with the host plant. The plant roots serve as a place for the fungus to live and reproduce. The fungus enables the plant to survive in areas where growth may normally be limited due to pH, high soil temperature, poor site quality, etc. This paper covers one effort in Virginia to "tailor" pine seedlings to a specific site.

In spring, 1974, one-year-old loblolly pine seedlings with and without **Pisolithus tinctorius** (Pt) ectomycorrhizae were planted in 12 isolated blocks on a coal strip in southwest Virginia where previous attempts at reclamation had failed. Block pH values averaged 3.4. Survival differences after two growing seasons were statistically significant, 70% versus 90% for Check and Pt seedlings, respectively. Such differences may or may not be of practical significance depending upon original densities and objectives for a given site. Height differences at planting (Pt seedlings were 29% taller) were essentially maintained for the first three growing seasons after outplanting, then increased to 40% and 41% during the fourth and fifth seasons, respectively. Stem diameters were not recorded at planting time, but diameter differences have averaged 25%, 43%, 42%, 44% and 44% after 1, 2, 3, 4 and 5 growing seasons, respectively, with the Pt trees being consistently larger. After 5 years, Pt trees had a 190% volume advantage over the Check trees.

Check trees have always appeared chlorotic and were extremely so after the 1976 growing season. During the winter of 1976-77, winter burn was severe. The average Check tree had 26% of its foliage burned; treatment trees averaged 6% burn. The more severe burn on Check trees probably held back growth in 1977 and allowed Pt trees to increase their advantage. After the 1978 season, differences in tree color, needle length, foliar density and total growth were dramatic.

AUSTINVILLE MINING — 1756 TO PRESENT

E. T. Weinberg
The New Jersey Zinc Company

The Austinville Mine is located 75 miles southwest of Roanoke, Virginia, in Wythe County. It constitutes the only active metal mine in the state and has enjoyed 223 years of activity. During that time, it has progressed from a handicraft, near-surface, labor-intensive industry to one that is mining at depth and is quite dependent on sophisticated machinery for ore extraction and beneficiation. The mine workings extend for approximately six miles along strike and one-half mile across strike. Levels are cut every 100 feet vertically down to the 1200 foot level. Entrance is mainly from two vertical shafts, although subsidiary ventilation shafts, adits, and mobile equipment inclines provide necessary escapeways and airways.

Austinville is an atypical, stratabound zinc-lead deposit in that it is located in a folded and faulted environment. Its host rock is the Shady Formation of lower Cambrian age, which is a dolomite in most of the mine area. Mining covers a stratigraphic interval of approximately 1400 feet and extends from near surface to the lowest mining level, 1100 feet below the shaft collar.

Production has been characterized by two separate periods with large qualitative and quantitative differences. The early period was one of desultory production, low tonnages, and high grades. Prior to 1870, mining was almost exclusively for lead. Between 1870 and 1924, this period of low production continued but included the oxidized zinc mineral, hemimorphite. After 1924, production rose rapidly with the advent of the flotation process for the concentration of the sulfide minerals and has included over 90% of the unknown ore to date, approximately 29,000,000 tons. Current production is approximately 500,000 tons per year containing 3% zinc, 0.4% lead.

The ore itself occurs in tabular lenses within discrete, favorable zones in the middle and lower Shady. These lenses average perhaps 400 feet in strike length, 100 feet in dip length and 10 to 30 feet thick. Individual lenses can and do vary considerably from the average. Some lenses are stacked vertically and can be mined concomitantly. Some, which are continuous for long strike distances, are especially amenable to mining by trackless mobile equipment. The smaller lenses still are best mined using jackleg drills and slushers. All long haulage is by rail to an underground crusher. The ore, crushed to a maximum four-inch size, is hoisted by automatic, six-ton skips to the surface where it is processed in a 2,500 ton per day flotation mill. The products are concentrates of zinc sulfide averaging 61.5% zinc metal, concentrates of lead sulfide averaging 75% lead metal, and finely-ground agricultural, dolomitic-limestone.

Ever since extensive mining has been pursued at Austinville, water in excess has been a problem. We are currently pumping about 13,000 gallons per minute or 19,000,000 gallons per day. Every new level or major development into new ground is equipped with water-tight, "bulkhead" doors which can be closed to protect the shafts and other mining areas from sudden inflows. The rock itself is generally impermeable except along fault or joint systems which provide the major hazards at depth. Oxidation along some of these fault systems has been observed as deep as 1,100 feet beneath the surface.

About this point in any discussion of Austinville, someone is sure to raise the question of mine life and reserves. It is not practical to refer to specific reserve figures since they are quite sensitive to economic factors. Austinville's current grade and tonnage targets, however, place it in a marginal economic category. The current squeeze between low base metal prices and high operating costs can only accelerate the tendency to premature closure before the real exhaustion of metal-bearing tonnages. Operating costs are especially responsive to energy and labor rates as well as to environmental requirements.

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KYANITE MINING IN VIRGINIA

G. B. Dixon, Jr.
Kyanite Mining Corporation

The mining of kyanite began for the first time in the history of the world in Prince Edward County, Virginia. The deposits were prospected by a Virginian, Mr. Joel Watkins of Charlotte County, during the 1920's. Mining has been discontinued in Prince Edward County and the quarry is being returned to grazing and forest land. The largest kyanite mining company in the world today has its headquarters in Buckingham County, Virginia and employs two hundred miners at the present time. There have been no serious environmental problems at this plant in its forty years of existence.

The world production of kyanite is estimated to be 200,000 tons of which 90,000 are produced in Virginia. Approximately 40 percent of this kyanite is exported through the port of Hampton Roads and brings money from other countries to Virginia. Reserves of kyanite in Buckingham County will last several decades. There are several potential prospects, both to the north and west of the present open-pit mining operation at Willis Mountain. Blasting is followed by crushing materials ½" in three stages. The primary crusher is a 50 x 60 jaw crusher. The processing is accomplished by milling in a 500 horsepower, 9½ x 12 rod mill followed by fatty acid floatation in 300 Cu. Ft. cells and then by drying in a rotary dryer.

A new high intensity wet magnetic separator is now being used to remove iron contamination additional processing includes calcining at 3,000°F and size reduction to -325 mesh. The calcined kyanite is called mullite and this material is used for operations where the expansion characteristics of kyanite are not desired. Kyanite and mullite materials find wide use in the refractory and ceramic industries. The largest portion of kyanite is used in making brick for rotary kilns and furnaces. Some new applications are being developed in manufacturing stainless steel and fiber insulation. In future years kyanite in Virginia may become the source of aluminum. The many uses of kyanite may be able to contribute to the solution of many of the complicated problems of this nation.

SCHEDULED MEETINGS

May 2 - 4 Eastern Section, National Association of Geology Teachers, New Kensington, Pa. (Jesse Craft, Dept. of Geology, Kent State University, Kent, Ohio 44242) Theme: Geologic hazards in the urban area.

May 13 - 16 Virginia Academy of Science at the University of Virginia in Charlottesville. The Geologic Section will be held on Thursday, May 15. (Contact: Charles Bartlett, 102 South Court, Abingdon, Virginia 24210).

June - July Environmental workshops pertaining to geology, soil and water, marine life, forests, and wildlife will be held in the following locations:

VPI & SU	June 17 - July 3
William & Mary	July 14 - August 1
Virginia State U	July 7 - July 25
Longwood College	June 16 - July 3

For more information regarding credits and scholarships for these three week courses contact: Virginia Resource - Use Educational Council, c/o Bernard L. Parson, Seitz Hall, Room 203, V.P.I. & SU, Blacksburg, Virginia 24061.

October 3 - 4 Virginia Science Teachers Conference in Fredericksburg (Teresa Myer, Department of Education, Box 6Q, Richmond, Virginia 23216.

November 17 - 20 Geological Society of America annual meeting in Atlanta. (Contact GSA headquarters, 3300, Penrose Place, Boulder, Colorado 80301).